IEA/SolarPACES Task I Meeting:
Solar Thermal Electric Power Systems

28 October 1998
Cuernavaca, Mexico

Meeting Summary

A significant fraction of the meeting focused on Sector 4, and understanding issues in getting solar thermal electric technology to the market. Opportunities in various world markets were discussed. The recent START-like mission to Mexico was reviewed, and options for supporting follow-on activities in Egypt and Jordan were discussed. Finally, the status of various projects in Sectors 1 and 2 were reviewed.

Task I Meeting

The meeting was convened by Craig Tyner, and welcoming comments were made by Carlos Ramos Berumen of IIE. Introduction of the agenda was made by Craig followed with a brief mention of the minutes from the last Task 1 meeting, the Annual Report, and the overview of STE technology prepared by Craig and Greg Kolb. Craig also asked for input to the report. Al Lewandowski and Michael Geyer provided comments.

Sector 4: Market Barriers and Opportunities (Tom Williams, Sector Leader)

Discussion of Status of Market Barriers and Opportunities, T. Williams, SunLab: Tom Williams led Sector 4 discussions. Tom stated the task objectives: that is, commercialization and associated market development. We want to change reality – make plants go in; understand what is happening in the markets; promote STE technologies. It is easy to promote, harder to understand markets, and it is very difficult to change reality.

Greg Kolb (USA) mentioned the potential of a trough project and a central receiver project in Mexico. Also, he mentioned an upcoming combined-cycle plant in Hermosillo, on which some will try to accommodate solar options. This is discussed later.

Opportunities in Australia, Wes Stein, Australia: The utility industry (about 48 GW total capacity) is undergoing privatization and de-regulation. Australia is 8% above its Kyoto commitment, which was actually an increase in emissions. The retailers may have to purchase 2% from renewables; 9,000 GWh is presently being considered for legislation. It is Wes' opinion that this will pass. This will be a ramped increase with 200 to 400 MW per year. This could be through a pool or through credits. There has been some discussion of a portfolio approach, but it probably will not make it legislatively. It is hoped that the laws will be enacted by early 2000. In NSW they are requiring retail licenses that require reduced CO2 emissions. ST has the same problem in Australia that it has in the US – no reliable plants currently exist (although if they came to Kramer Junction, proof of success would be adequate). There are green power schemes in Australia. About 25% of the people opt for this option with additional cost of about $5 per month.

Wes also noted that there are limited sites in Australia where grid capacity is high, there is good

insolation, and natural gas is available. Distributed generation may be the best way with small plants in the size range of 15 – 20 MW. Part of their focus is to create Australian industry. They feel that as much as 400 MW of solar thermal power could play in Australia over the next few years. This is being focused as part of the PM's program, which is much broader, to cut green house gases through improvement in efficiencies across the board. The proposals for achieving this are industry driven, and, therefore, it is believed that they will be more likely to become law.

Wolfgang Meike (Australia) mentioned that from 2 – 200 kW remote power may find their way into various opportunities in the Northern territory for air conditioning loads backed by small diesel operating at high efficiency. The biggest saving is the deferred capital investment. Capacity around Australia includes: 87% major utility grid systems, remote 5%, IPP 2.7%. Remote still offers a starting point for renewables. Current costs for bulk power have dropped from 4 to 2 ¢(Aus)/kWh.

Wes believes that hybridization is the "low-hanging fruit." There are some projects currently under consideration. Most of the new plants that are going in are natural gas. Craig Tyner suggested an industry-based Start Mission to Australia that would provide an opportunity for marketing of ST systems early in the renewables implementation.

Opportunities in Mexico, Greg Kolb, USA: The utility world has changed – the utilities will not exist in the same form that they used to. IPPs build and operate and hold the risk. Risk avoidance is the main thing. Greg reported that small projects involving modular systems might be involved, especially from dish/Stirling. Manuel Romero reported that he heard from the START Mission yesterday that Mexico might be an opportunity. Greg's bottom line is that dishes will survive. Trough plants are considered in Crete, Egypt, India, and Mexico and the prime focus is development of a lower-cost 4th generation trough design. Power tower plants probably have no applications and the primary driver is development of a lower-cost heliostat drive.

Greg proposed a power tower plant in Mexicali as a possible next step. He proposed 30 MW with a 43% capacity factor, in a combined cycle plant. Greg presented a proposal for $120M for the project. From the Power Tower roadmap, financial providers suggested that the equity would have to be 90 – 100%. He also offered a breakdown of potential equity investors for a project.

Opportunities in South Africa, Tom Williams, USA: Tom described the ESKOM (the SA utility) STE and wind project and the GEF project in South Africa. Some of the feedback from the GEF indicated that they did not want to see a project requesting development funding. The reasons for this are that the GEF has too many projects on the table for STE, so they may be over committing; therefore, they are concerned; they are now nervous about what the total subsidy bill would be to get to parity with fossil fuel. They are also concerned about the variations in trough technologies, different ST technologies, and what is the tech transfer to future projects.

Three GEF pre-feasibility projects are firm – Egypt, India, Morocco, and Mexico is a potential fourth country. There is a lot of discussion about minimum solar fraction for a GEF project; a 12% minimum requirement is still uncertain, however.

German Issues, Robert Pitz-Paal, Germany: The Synthesis Program developed to penetrate markets with 50 trough plants up through 2010 with an investment of about 25 billion DM ($50B US). This will require about 1.6 billion DM subsidies in the next 5 years. A consortium of banks (with members yet undisclosed) will provide for special interest rates from banks and insurance companies. They recognize the potential to earn money in the long term. They get a preferred position for future projects. An initial interest rate of 2% for an entire project on a 30% equity position for even a very small solar fraction is expected. The THESEUS project is the first project expected under this program.

Spanish Issues, Manuel Romero, Spain: Manuel described the situation for the evolution of the "white paper" in the European Union. The objective of the paper is to duplicate renewables by 2010 up to a

12% contribution; the first draft was released in Nov 97. Basically, the draft focused on biomass and wind. National white papers are to be prepared by the end of 1998. The document from the Commission does not include STE power. There is an item for other renewables, which would include STE.

In Spain they are trying to lobby. The Commission is trying to determine how to manage the funding for the incentives as well as a request to reduce local hurdles to implementation. Spain is deregulated with green pricing decreed for co-generation and renewables. Green pricing of 24 cents per kWh (solar only) is likely (although targeted for PV, it would also apply to STE).

General Discussion: In general discussion with the group, Tom Williams develop a list of follow-on activities, including potential projects outlined in Table 1. Those most likely to be followed-up on include:

- Database of commercial projects – Mancini, Geyer, Kolb. (could also be expanded to include renewable portfolio standards (Williams, Stein, Kistner), known green market mechanisms, opportunities for subsidized projects, etc.)
- Replication study on troughs – Price, Trieb, others TBD (to help determine how many plants it would take under various scenarios (location, etc.) to bring the technology to competitiveness).
- Different type of industry-oriented START mission to Australia (and other places) – Tyner, Meike, Stein, Geyer

On a closing note, Michael Geyer raised the issue that we do not have enough industry involvement in our working group.

Sector: 3 START Missions (Michael Geyer, Sector Leader)

START-Like Mission to Mexico, Greg Kolb, USA: The START-like meeting was held at the CFE Technology Museum with attendance of 30 people from research institutes, universities, minister from energy department, ABB Mexico City, Pemex. It started off with the status of Mexican solar thermal activities: insolation monitoring, 10 kW trough system, Puerto Lobos project, dish in Cuernavaca, thermochemical storage, and CPC pressure cookers developed in Toluca. Carlos Ramos gave an overview of studies done by IIE: formed in 1979, central generation in power plants, PV station, DLR study on Mexico building a heliostat, air receiver with Boeing, heliostat control software, trough feasibility studies with LUZ, Dyncorp, Meridian, and Cummins working on dish marketing studies, and currently a project with Pemex to use solar in the oil refining process.

The SolarPACES Team gave a broad look including water desalination, disinfection, materials processing, electric power generation. Highlights of round table discussions included ISCCS activities involving Byron Washom (World Bank wanted CFE to be privatized before they could proceed) and decision that the Hermosillo project will be a private site (World Bank found this to be okay). A winner has already been selected -- Union Fenosa and ABB. ABB is interested as a possible future activity.

The winning bid was 3.8 cents/kWh. There is a gas shortage in Hermosillo and the power output of the combined cycle plant will decrease in the summer. Consumption patterns are similar to the U. S. with air conditioning loads. This would be an independent activity with the IPP. November 3 the World Bank will send a team to determine if Mexico is still interested in pursuing a solar thermal project.

CFE will not invest in solar, although they will support it if the public is interested. The Director of planning for the Energy Department indicated that the country needs to develop a legal framework to encourage investors to invest in Mexico. They were also concerned whether the plant will stand on its own merit and be profitable.

Regarding a power tower in Mexicali, Claudio Estrada raised the issue of what the plant should be used for in terms of the interests of the research community. A plant in Mexico could sell power to the U. S.,

although whether it would be eligible for GEF funding was not known. COFER is organization of CONAI for people from different institutions, and they provide input to policy.

People from other industries – water purification, desalination, mining, etc. – were invited but did not attend. The Mexicans are interested in desalination. Our input is that this should be done as part of a co-generation application. Carlos expressed the opinion that dish/engine systems are interesting to them. Water is a major issue for Mexico.

Egypt and Jordan update, Michael Geyer, DLR/PSA: Other START mission host countries would not have an interest in applying if the GEF will not accept applications. Post-START mission could be done in Egypt and Jordan to get political partners interested in the approach. The next step is to bring in financial institutions, banks, and industry suppliers. The idea here is to bring the parties together to try to make the projects happen. There was some discussion about where our involvement stops and industry must take over to "carry the ball." Our recommendation to the ExCo is that SolarPACES should participate in the Egyptian planning meeting.

Sector 1: Central Generation Systems (Wolfgang Meike, Sector Leader)

Update on THESEUS Project, Michael Geyer, DLR/PSA: One year ago the project seemed to be dead. Then the project was changed to be an IPP project that is 50 MW with 10% fossil fuel within the legal constraints. They may use fuels that do not damage the environment, so they will use gas. The ENRON PV project on Crete is dead (Michael thought that Solarex would sell more expensive projects). So, THESEUS seems to be back on track. The remaining consortium is Fichtner, Pilkington, Abengoa and Greek Constructor, and Bechtel Europe as the operator.

EuroTrough Project, Michael Geyer, DLR/PSA: Inabensa, SBP, Fichtner, Pilkington, CIEMAT, DLR, CRES are involved with the objective of developing troughs for less that $200/m^2$, and getting detailed trough design drawings into the hands of industry. The consortium will meet at KJC next week to get an update on the status of their business. U. S. industry can and may become involved in the consortium. The time schedule is 2 years with the potential to put troughs at the PSA and potentially at KJC, if they decide to be involved. The total project budget is 2.4 million ECU.

SolWin Performance Model, Michael Geyer, DLR/PSA: The SolWin project is to provide a first-level tool for showing the incremental cost of STE-hybrid systems versus fossil fuel or other renewable projects. The programmatic structure is defined. The cash flow models are more detailed than the physical system models. Testing of the tool is the next step.

Solar Two, Greg Kolb, USA: ESI assumed operation of the plant in Feb 98. A period of slow learning how to operate the plant followed. We are now close to operating to get the most energy possible. Some forced outages are still experienced, but nothing catastrophic. Steam generator design issues have been resolved. The plant has been running routinely for almost a year. On one day, the plant generated 105 MWh of net power generation. The plant was then run continuously for one week (153 hours straight). The generator peak gross output has been 11.6 MW. Peak efficiency of Solar Two is 13.5% where a commercial plant would be near 23%. Two nagging problems remain: tube headers are too cold at start up; and the heliostat field has substantially degraded and availability is low. Solar Two may shut down in the spring or summer.

Australian Projects/Showcase Funding, Wesley Stein, Australia: The Prime Minister's initiative is to reduce CO2 production. The two technologies are the Big Dish (DSG now, maybe a Brayton in the future) and linear Fresnel technology. Two projects awaiting government funding. Hybridized linear Fresnel troughs will be utilized with a coal plant (4MWe) near Brisbane to demonstrate the technology. The second project is to use the Big Dish (2 ½ MWe) as steam generation as well. Showcase funding is $6M USD and expected to get political repercussions with 45 applicants and potential for funding only

three.

Sector 2: Distributed Generation (Tom Mancini, Sector Leader)

Distal Update, E. Luepfert, DLR/PSA: The hybrid HYPIRE receiver is to be installed soon on Distal II. Routine daily operation of 6 installed dishes continues. 30,000 hours have been put on Distal I, hours on Distal II unknown.

EuroDish, E. Luepfert, DLR/PSA: The main objectives of the Euro-dish project are: cost reduction (drive, controls, concentrator) to below $6/kWe for dozens units/year, Stirling optimization, remote control via WWW. Partners include SBP, SOLO, Mero (steel), Klein&SteRkl (concentrator – may not be stretched membrane), Inabensa (steel), CIEMAT, and DLR. Redesign is underway, with installation of 2 new units by 2000. Regarding funding, MERO is the biggest contributor.

USJVP, Thomas Mancini, USA: The objectives of the project are to deploy 3-5 systems and achieve 750 operational hours. Two systems have been installed in DC and Golden and have achieved 462 hours of solar operation and 111 hours of gas-fired operation (no combined solar/gas). Some of the project issues are frequent design changes, structural deflections, dish/engine controls, and power electronics. The current status of the project is a re-negotiation of Phase II for the fielding of 3 systems. Additionally, there was a realization that more research is needed than originally thought. Goals for Phase II are: 100 MWh generated by 3 systems, MTBF at end of year >=500, 750 hours of autonomous operation of a single system. Phase III of the USJVP may involve providing 500 kW of power for the utility (PNM) in New Mexico. Negotiations are still underway.

DECC Projects, Thomas Mancini, USA: The Dish Engine Critical Components projects are with Boeing and Allied Signal. The goal of these projects is to first focus on the power conversion unit. Phase I is operation and documentation of engine performance. Phase II is systems integration and operation and Phase III is system deployment. The Allied Signal project was to test a Brayton PCS on the Sandia TBC dishes; however, little progress has been made. There were difficulties selecting receiver technology, and the A/S management has withdrawn from the project to focus on core business topics. A new option being discussed with another division within A/S that would use a larger Brayton that is being developed for other markets. That project would begin next year.

The Boeing project is based upon licensed McDonald Douglas technology with a Kokums PCU. It has over 118,000 hours on the engine. The philosophy is to make only minor changes in Phase I and test one engine in the laboratory and one on-sun. In Phase II, the concentrators and controls would be updated. They are targeting the Arizona and Nevada markets. To date, the system has operated for 625 hours (74 days w/o forced outage), producing a peak 21.1 kWe. In Phase II, six more concentrators (2 of a new design) would be installed and 10 new engines built, plus 2 more old engines refurbished. Phase III would be to install 1 to 2 MWe of plants.

German-US Cooperative Engine Test Project, Thomas Mancini, USA: The Ft. Huachuca SERDP project uses the Cummins 7 kWe system. When Cummins exited the program, the program continued with the military base. There have been discussions of testing a SOLO engine on the system and/or a heat pipe receiver. A SOLO engine was installed in 1998, but no receiver test will likely occur. Systems issues/integration were problems, limiting it to 100 hours of operation in 1998. Hail damage to the polymer film mirrors was repaired, and control problems addressed. A structural tripod was also replaced and a pressure transducer awaits replacement.

Next Meetings:

The next Task I meeting will be held in Israel in June 1999, in conjunction with the ExCo and Task III meetings, as well as the ISES Conference in Jerusalem.

The following Task I meeting will tentatively be held in conjunction with the 10th International Symposium on Solar Thermal Concentrating Technologies (and ExCo, Task II, and Task III meetings), in Sydney, Australia, in March, 2000.

Task I Meeting Action Items (all designated 9810-#):

1. Investigate options for getting guest speakers at Task Meetings (project development, financing, etc., but not STE) – Tyner.
2. Provide Mexico START-like mission VGs to Tyner before ExCo – Kolb.

Appendix A: Meeting Agenda

IEA/SolarPACES Task I: Electric Power Systems Task Meeting

Cuernavaca, Mexico

Wednesday, October 28, 1998

Agenda

09:00	**Introduction and Opening Remarks (Craig Tyner, Operating Agent)**	
09:30	**SECTOR 4: Market Barriers/Opportunities (Tom Williams)**	
	Extended discussions, including new directions	Tom Williams
	Australian opportunities	W. Meike
	Other?	
13:00	LUNCH	
14:00	**SECTOR 3: START Missions (Michael Geyer)**	
	START Mission to Mexico – general discussion	M Geyer/Greg Kolb
	Follow-on START Mission to Egypt/Jordan - Status	M Geyer
	BG Power Generation Briefing – London	C. Tyner/M. Geyer
	1999 START Mission options	M Geyer
	Other?	
15:30	BREAK	
16:00	**SECTOR 1: Central Generation Systems (Wolfgang Meike)**	
	Theseus project update	M. Geyer
	EuroTrough project description	M. Geyer
	SolWin performance and financing too	M. Geyer
	Solar Two	G. Kolb
	Other?	
17:00	**SECTOR 2: Distributed Generation Systems (Tom Mancini)**	
	Update on Australia's Solar Thermal Activities	W. Meike
	DISTAL 2 Project Update	E. Luepfert
	German EuroDish Project	E. Luepfert
	U. S. USJV Project (SAIC)	T. Mancini
	U. S. DECC Projects (Allied Signal, Boeing)	T. Mancini
	German-US Cooperation Project (Ft. Huachuca)	T. Mancini
	Other?	
18:00	**Additional Business, Action Items (Tyner)**	
18:30	**ADJOURN**	
	Additional Meetings:	
	Tuesday, October 27, Mexico City: Mexico START Mission	
	Thursday, October 29, Cuernavaca, Task III Meeting	
	Friday, October 30, Cuernavaca, IIE Tours (?)	

Appendix B: Meeting Participants

Appendix C: Presentation Summaries